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ANALYSES OF ALTERNATIVES (AoAs) ACROSS THE MILESTONES

Dr. George Akst

Senior Analyst

MCCDC

Purpose of an AoA

- **An Analysis of Alternatives (AoA) can:**
  - **Illuminate risk, uncertainty, and relative advantages and disadvantages of alternatives**
  - **Show sensitivity to changes in key assumptions**
  - **Help decide whether military/economic benefit is worth the cost**
  - **Help to refine requirements documents (CDD, CPD)**
  - **Address "affordability"…**
    - **The degree to which the life-cycle cost of a program is in consonance with the long-range investment and force structure plans of the …Component**

AoA Issues at Various Milestones

- **Broader, more general questions at early milestones; more focused as the program matures**
- **Case Study for the Expeditionary Fighting Vehicle (EFV)***
  - **Milestone I: Concept Development**
  - **Milestone II: Engineering Development**
  - **Milestone C: Limited Rate Initial Production (LRIP)**

How have the questions/issues changed to support these different decision points?

***Formerly the Advanced Amphibious Assault Vehicle (AAAV)**

Outline

- **Background**
- **Milestone I COEA**
- **Milestone II AoA**
- **Milestone C AoA Update**
- **Conclusions**

Previous History of Amphibious Vehicles

- **LVT-7 begins fielding in 1972**
  - **Slow swimming (~7 knots)**
  - **Weapon station: 50-caliber machine gun**
- **Late 1970s: LVA program to develop fast swimmer**
  - **COEA: technology couldn't support program**
- **Early 1980s: Upgrade to AAV7A1**
  - **Upgunned weapon station: 50-cal/40mm grenade launcher**
- **Mid 1980s: LVT(X) program to enhance firepower**
  - **COEA: Military benefit not worth the cost**
- **Late 1980s: AAAV program born**
  - **Fast swimmer and enhanced firepower**

Outline

- **Background**
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Milestone I Cost and Operational Effectiveness Analysis (COEA)

- **Helped to refine the Operational Requirements Document (ORD)**
- **Narrowed the field from the broad array of possible candidates**
- **Supported the Technology Development Strategy**

Summary of Milestone I COEA

- **Examined 13 alternatives**
  - **Fast swimmers: AAAV(F); AAV7A2(F)**
  - **Slow swimmers: AAV 7A1; AAAV(S); AAV7A2(S); submersible**
  - **Non-swimmers: Bradley; LAV-25; M113A1; APC(X); FIFV**
  - **Non vehicles: All surface (LCAC); All air (MV-22)**
  - **And also mixes**
- **Screened out alternatives based on cost & performance**
  - **AAV7A2(F); submersible; LAV-25; FIFV; all air; Bradley**
    - **Bradley placed back in mix by ASN (RD&A)**
- **Supplemental analysis examined mixes and modular construction of AAAVs**

Summary of Milestone I COEA (Cont)

- **AAAV(F) best performer and most effective**
  - **Used campaign-level model (AWM) on 2 scenarios**
  - **MOEs: Loss exchange ratio; force movement; fraction surviving; ship-to-shore timelines**
  - **Influencing factors: speed (faster build-up) and firepower**
- **But also substantially more expensive**
  - **Not so if we account for number of ships to carry 3 MEBs**
- **Procurement strategies**

(Fast swimmers for all amphibs; slow swimmers for rest)

  - **Some advantages of higher effectiveness at lower cost**

Outline

- **Background**
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What Should a Milestone II AoA Include?

- **Answer depends on:**
  - **What was included in Milestone I AoA/COEA**
  - **What has changed since?**
- **Contention:**
  - **Milestone II AoA should avoid duplication as much as possible**
  - **It should focus on the key issues of the time**
- **Above all, remember goal is to support decision on whether or not to proceed into SDD**
  - **Not narrowing down design decision**
  - **Not nailing down detailed fielding plan**

COMPONENTS OF AoA

- **Develop alternatives**
- **Effectiveness analysis**
- **Logistics supportability**
- **Cost analysis**
- **Historical comparisons**
- **Affordability analysis**
- **Conclusions**

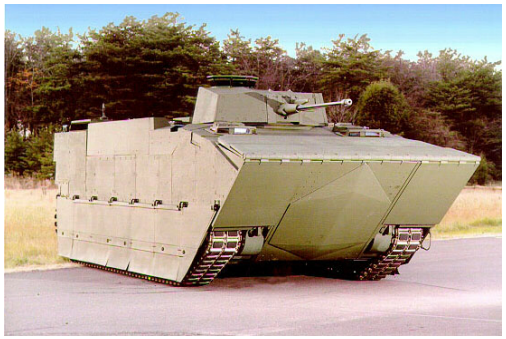
Alternatives

AAV RAM/ REBUILD (RS)

AAV IMPROVED AAV(I)

- **Achievable performance improvements**
- **Substantial cost savings (over AAAV)**

AAAV

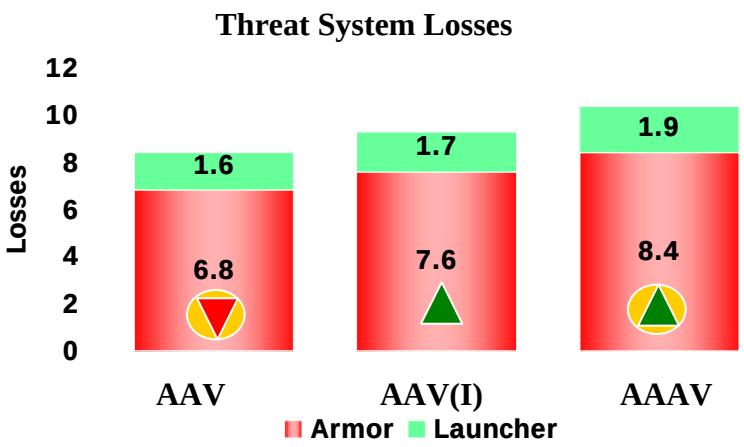


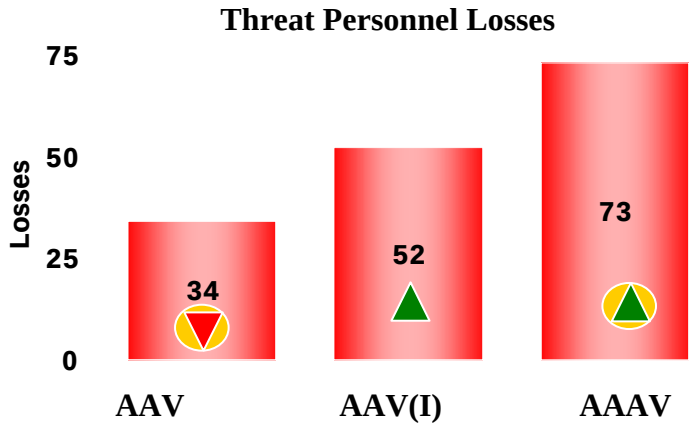
Reduced Procurement Objective

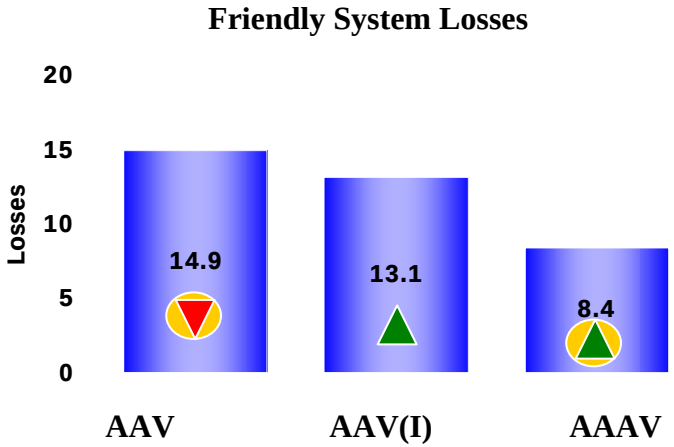
Stretched procurement

- **Mixed fleet**
  - **AAAV, AAV(RAM/RS)**
  - **AAAV, AAV(I)**

Results: Maneuver at Sea (LPS 3) Night; High Tech Threat; AAVs Ride







Statistically worse than all alternatives

Statistically better than Baseline (AAV)

Statistically better than all alternatives

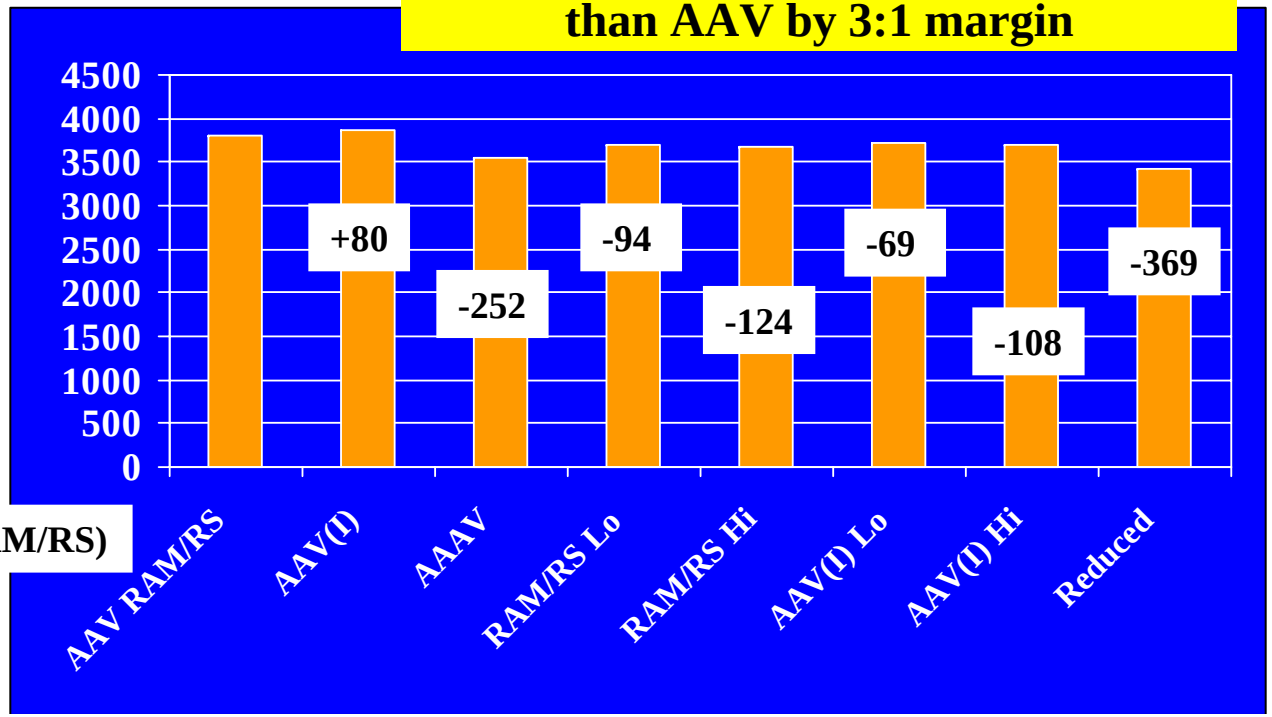
Logistics Supportability

- **Reliability**

	AAV RAM/RS	AAV(I)	AAAV
MTBOMF (hours)	43.5	37.2	70.0
MTTR (hours)	2.3	2.4	1.5

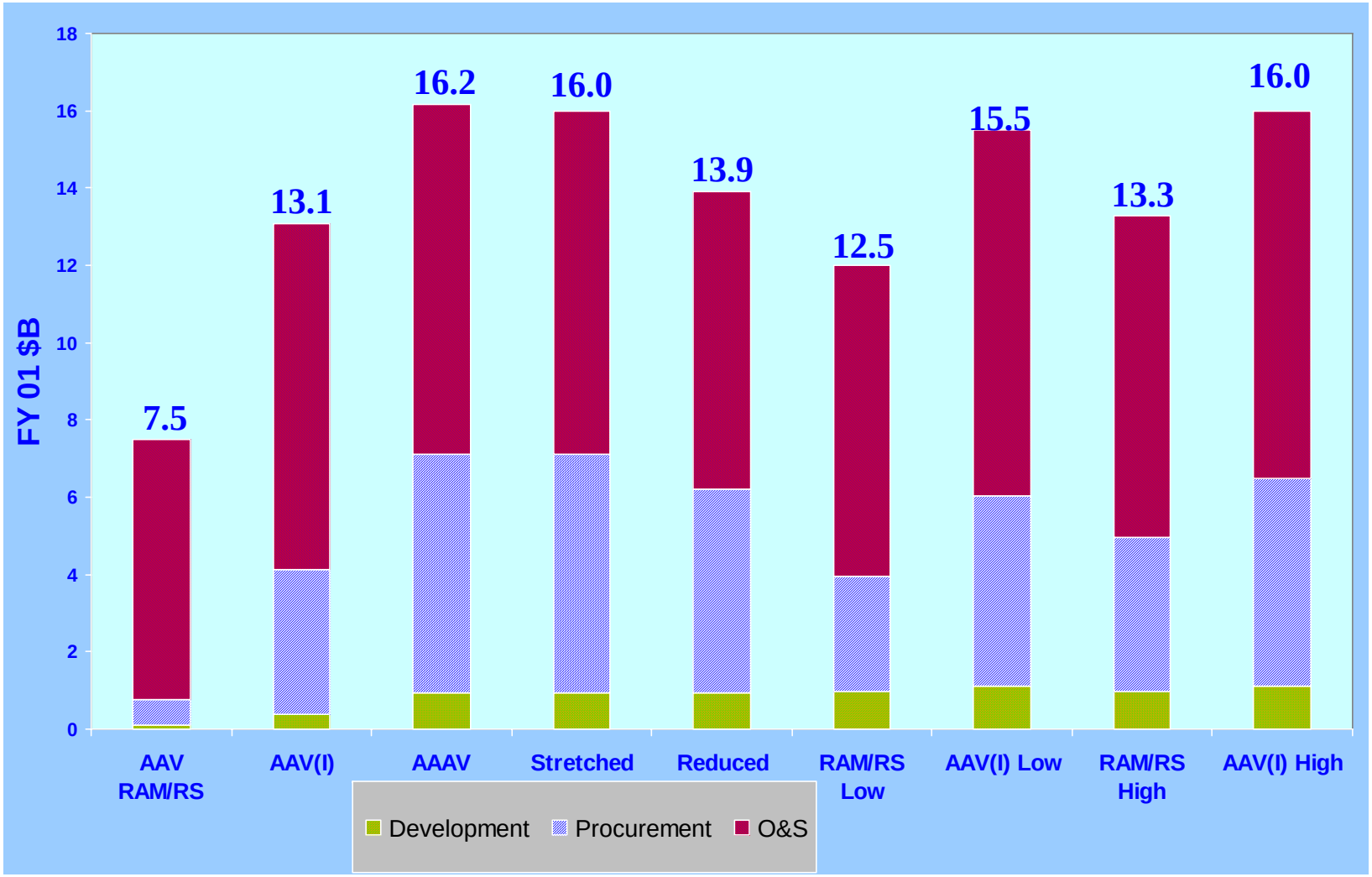
Maintenance ratio: AAAV better than AAV by 3:1 margin

- **Personnel**



Change from baseline (AAV RAM/RS)

Summary Life-Cycle Costs (By Phase)



Conclusions

- **AAAV substantially better in performance and effectiveness than other alternatives**
- **Stretched procurement address near-term bow wave, but not long-term affordability**
- **Reduced procurement achieves significant savings but with some operational risk**
- **AAV RAM/RS mixed fleets provide substantial savings, with benefits of AAAV, but also add some operational risk and maintainability issues**

Recommendations

- **Decision at hand is whether or not to proceed into E&MD for the AAAV**

- **All viable alternatives contain AAAV**

- **Proceed into E&MD for AAAV**

- **Weigh RAM/RS mix and procurement strategies against affordability concerns in near-term (POM 04?)**

Outline

- **Background**
- **Milestone I COEA**
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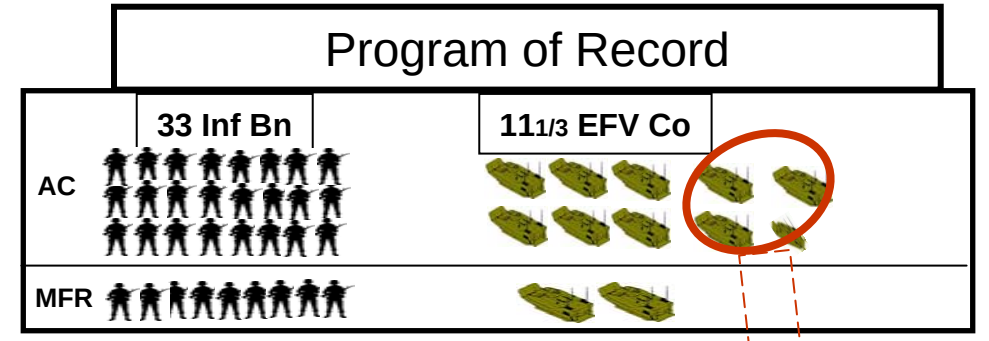
- **Conclusions**

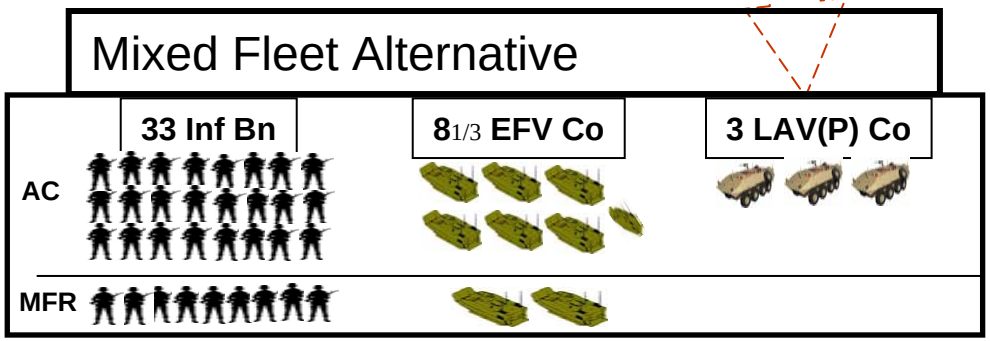
Milestone C AoA “Update”

- **Several things have changed since last Milestone and AoA**
  - **Reliability KPP decreased**
  - **Costs have increased**
  - **Program changed to reflect SPG direction**
- **OSD requested AoA update to address changes**

Alternatives



1,013 EFVs



573 EFVs

581 LAVs

- **498 LAV(P)**
- **24 LAV(C)**
- **21 LAV(R)**
- **38 LAV(L)**

Life Cycle Cost Estimates
FY07$B (40 year life)

	RDT&E	Procurement	O&S	AVTB	Facilities	Total
EFV POR	$0.9	$10.9	$15.6	$0.1	$0.06	**$27.5**
Mixed Fleet	$1.0	$8.0	$13.4	$0.1	$0.06	**$22.5**

O&S Cost Implications of Reduced Reliability (in $B FY07)

	70 hours MTBOMF	43.5 hours MTBOMF
POR (1,013 EFVs)	$15.27	$15.64
Mixed Fleet (573 EFVs)	$10.32	$10.54

Summary

- **Mixed-Fleet alternative maintains significant forcible entry capability**
  - **Two MEBs as directed by SPG**
  - **All amphibs and MPF(F) equipped with EFVs**
- **LAV(P) augmentation provides equivalent tactical lift capability**
  - **Enhances potential for support to Irregular Warfare**
- **Mixed Fleet saves $3B PMC, $5B life-cycle**
- **Mixed Fleet increases risk in training (EEAP) and MCOs (reduced firepower)**
- **Reliability changes increase overall O&S by about 5%**
- **EFVs still required for forcible entry**

Mixed Fleet a viable option for future Marine Corps capabilities

Outline

- **Background**
- **Milestone I COEA**
- **Milestone II AoA**
- **Milestone C AoA Update**
- **Conclusions**

Conclusions

- **Alternatives will be broader at earlier milestones**
- **Level of detail will typically increase at later milestones**
- **Milestone C AoAs are the exception**
  - **Only required when specific areas demand additional investigation**

It is important to continually bear in mind the decisions to be made at the milestone when structuring the AoA

There is no "cookbook solution" to performing and AoA – they must be customized for each milestone

Backups

Limitations of Analysis

- **Effectiveness**
  - **Only addresses "pure" alternatives**

  Summary explores operational implications of others
  - **Does not fully account for command and control capabilities**

  Provided equivalent C-variants in all alternatives
  - **Limited to two scenarios**

  Did extensive exploration in vignette analysis, and sensitivity analysis

- **Logistics**
  - **Not completely independent estimates (reliability, operational profile)**

  Included sensitivity analyses in cost analysis

Limitations of Analysis (Continued)

- **Cost analysis**
  - **Alternatives are not always directly comparable (age of alternatives, phasing, etc.)**

  Attempted to even playing field as much as possible: Total vehicle-years; added substantial SLEPs

  - **Did not account for contractor logistics support**

  This could theoretically provide benefit to all alternatives; because it is yet to be substantiated, and would not be a discriminator, it was not considered.

Effectiveness Analysis Scenarios

- **Vignettes**
  - **Smaller, more focused**
    - **Maneuver at sea**
    - **Meeting engagement**
    - **Hasty defense**
    - **Attack on a deliberate defense**
  - **Use for exploring system capabilities, sensitivities**

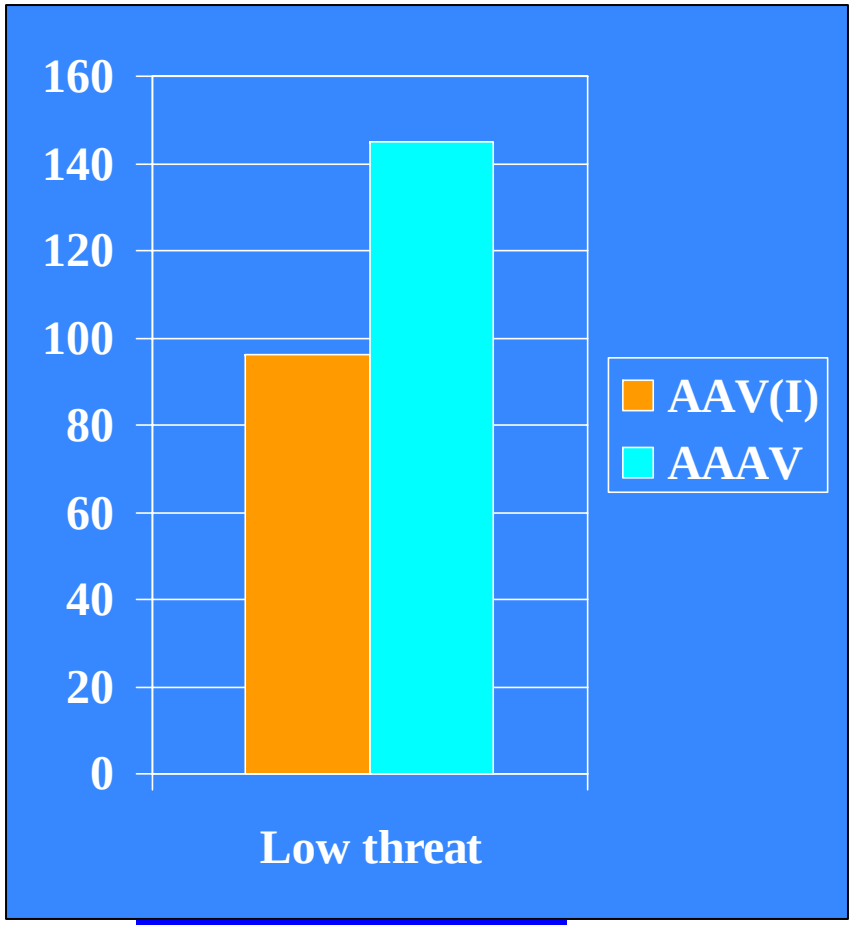
- **Scenarios**
  - **Use for main runs--operational-level analyses**
    - **MTW-E -- amphib assault**
    - **Lesser Regional Contingency (LRC) - SLOC**

Scenario Sensitivities

- **Threat levels**
  - **Projected vs. high technology threat**
- **Day vs. night**
- **Maneuver at sea**
- **Water Speed: 20 kn (threshold) vs 25 kn (objective)**
- **NBC Threat**

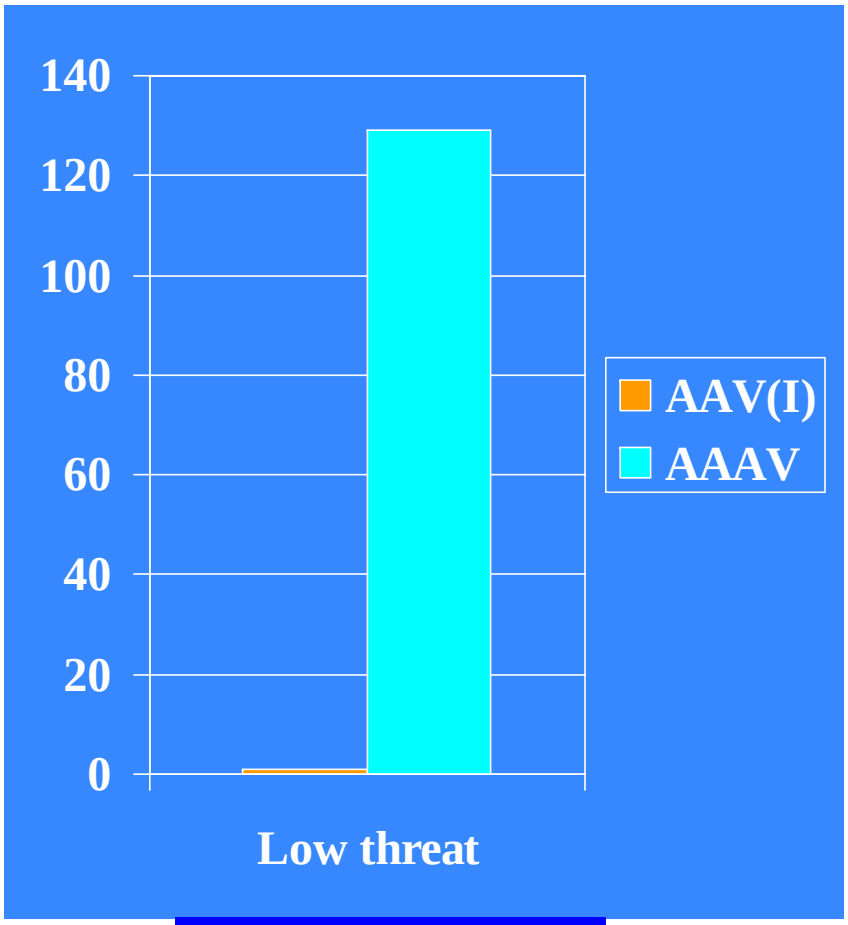
Effectiveness Summary (Comparison of MOEs)

Comparison to AAV RAM/RS



Maximum Score: 224

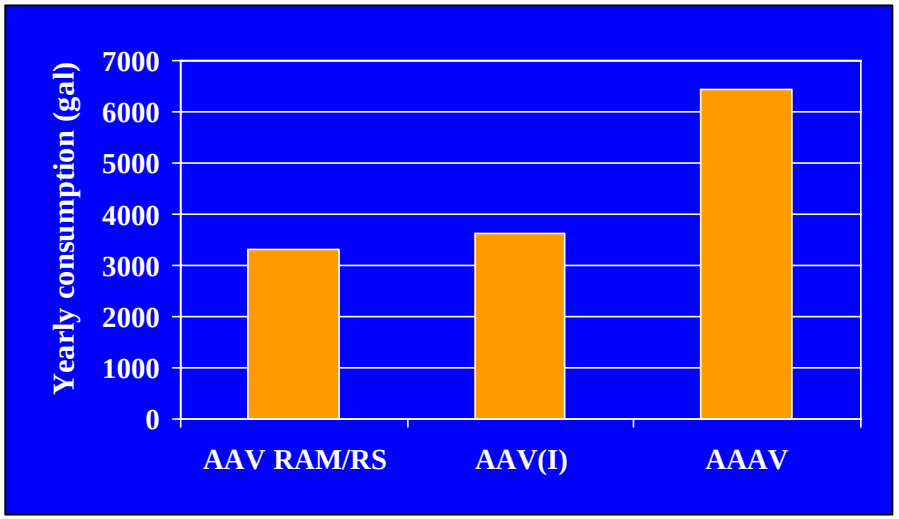
Comparison to each other



Maximum Score: 224

Logistics Supportability (Cont.)

- **Fuel consumption**
  - **Based on 150 hours/yr**
  - **Alternatives comparable on a per-mile basis**
  - **Sensitivity analysis**



Munition	Rounds per Active Vehicle per Year
40mm	576
.50 cal	3,370
7.62mm (on C- and R-variants)	650
30mm	1,100
7.62mm (on AAAV-P)	4,500

Historical Analysis

- **Examine historical Marine Corps operations**
  - **STARLIGHT (VietNam); URGENT FURY (Grenada); SHARP EDGE (Liberia); DESERT STORM (Iraq); RESTORE HOPE (Somalia)**
  - **Of these, which could have benefited from AAAVs?**
- **Similar analysis for projected future operations**
  - **Selected from Dynamic Commitment vignettes**
  - **NEO and peacekeeping/HA operation**

Historical Analysis (Continued)

- **AAAV would provide better:**
  - **Operational flexibility: Better exploit STOM**
    - **Eliminate operational pause**
    - **Reduce chances of landing on defended beaches**
  - **Operational tempo: Allows fully capable night operations**
  - **Firepower and survivability: Collective protection**
- **AAAV also has two major shortcomings:**
  - **Lack of three-shot line charge**
  - **Reduced cargo-carrying capacity**

Conclusions (Pure Alternatives)

- **AAAV substantially better in performance and effectiveness than other alternatives**
- **AAV(I) buys some increase in effectiveness**
  - **Still has significant operational shortfalls**
  - **Life-cycle cost over 80% that of AAAV**
- **AAV RAM/RS substantially lower in effectiveness**
  - **Significant operational shortfalls**

Eliminate AAV(I) and AAV RAM/RS pure alternatives from further consideration

Conclusions (Procurement Strategies)

- **Stretched Procurement**
  - **Achieves nothing toward long-term affordability**
  - **Addresses near-term bow wave**
    - **Saves about $300M/yr PMC during peak years (2008-10)**
    - **Pushes an additional $800M further down the bow wave**
- **Reduced Procurement**
  - **Achieves actual near-term savings of $900M (PMC)**
  - **Adds additional savings of $1.3B in long term (O&S)**
  - **Incurs some risk from fleet reductions**

These strategies warrant further consideration in conjunction with affordability concerns

Conclusions (Mixes)

- **Eliminate AAV(I) mixes**
  - **Almost as expensive as AAAV, with less effectiveness**
- **RAM/RS mixes provide substantial savings with added benefit of AAAV**

	AAAV	Low Mix	High Mix
Life Cycle ($B)	16.2	12.0	13.3
Procurement ($B)	6.2	3.0	4.0

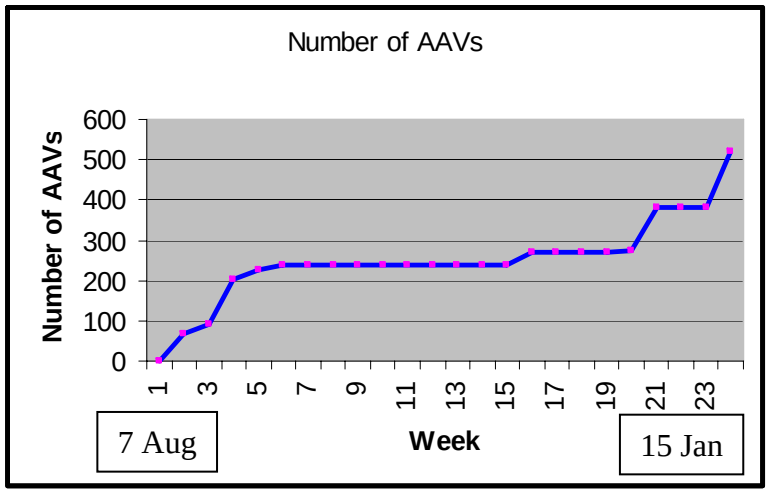
  - **Affordability: Low mix can reduce expenditures by almost $300M/yr throughout DPP**

Concerns About Mixes

- **Effectiveness of mixed fleets**
  - **Serious concern – leads to increased operational risk**

    however
  - **"Loading up" of all amphibious ships requires**

(2.5 MEBs) x (103 amtracs/MEB) x (85% avail.) = 219 amtracs



Concerns About Mixes (Cont.)

- **Overhead of maintaining two fleets of vehicles**
  - **Cost analysis incorporated much of this**
- **Problems with training with two different vehicles**
- **Operational risk**
  - **Can reduce effectiveness in 2nd, near-simultaneous MTW**
- **Age of AAV RAM/RS**
  - **Basic hull would approach 50 years**

    however
  - **Current assessment of hull is that it is adequate**
  - **Alternative (and corresponding cost) includes substantial SLEP during mid-life**

Capabilities Comparison

- **CONOPs**
  - **Both alternatives provide 2 MEBs forcible entry capability**
  - **Both alternatives equip MPF(F) with EFVs**
  - **POR provides infantry battalion EFV capability at 29 Palms, vice company for Mixed Fleet**
  - **Mixed Fleet provides less threatening alternative for lesser contingencies**

EFV versus LAV(P) Comparison

- **Survivability**
  - **Blast and ballistic protection comparable**
  - **Mine protection better for EFV**

Capabilities Comparison (Cont)

EFV versus LAV(P) Comparison

- **Firepower**
  - **EFV significantly more capable**
    - **30mm stabilized cannon vice pintel-mtd 7.62mm MG**
- **Mobility**
  - **LAV offers no surf or open-ocean mobility**
    - **Must ride on connectors from ship to shore**
  - **Land mobility comparable on open terrain, but tracks always more capable than wheels**

Shipboard Implications (for 2015 Notional MEB)

	Square (1000 sq ft)	Weight (1000 lbs)
EFV	35.3	6,272
LAV	42.9	7,348

- Relative differences significant (LAV over EFV)
  - 22% increase in square; 17% increase in weight
- Absolute increase for entire MEB only 2%
- Only impact on MPF-legacy or black-bottom
  - Both alternatives have EFVs on amphibs and MPF(F)

Assumptions

- **Actual procurement costs for current EFV prototypes used to project average unit costs in production**
- **Delivery profile and fielding plans based on POM-08**
- **Excursion assessed additional impact of rate reduction from POR**
- **RDT&E effort, with 7 prototypes, necessary to convert the existing LAV-L into a personnel carrier estimated by PM LAV**
- **For procurement, LAV-L used as an analogy for LAV-(P). For O&S costs (e.g., operating hours), LAV-25 used as an analogy.**

Rate Effect Excursion

- **Basic assumption was that learning (cost improvement) curve accounts for rate**
- **However, we ran a sensitivity analysis adding in an additional, partial reduction due to rate**
  - **Modeled with a rate slope of 95%**
  - **Adjusted costs to align POR costs**
- **EFV procurement costs in Mixed Fleet alternative rise from $6.65B to $6.87B**
  - **Increase of 3% in Average Unit Cost**

MS C Update analysis – Surface STOM

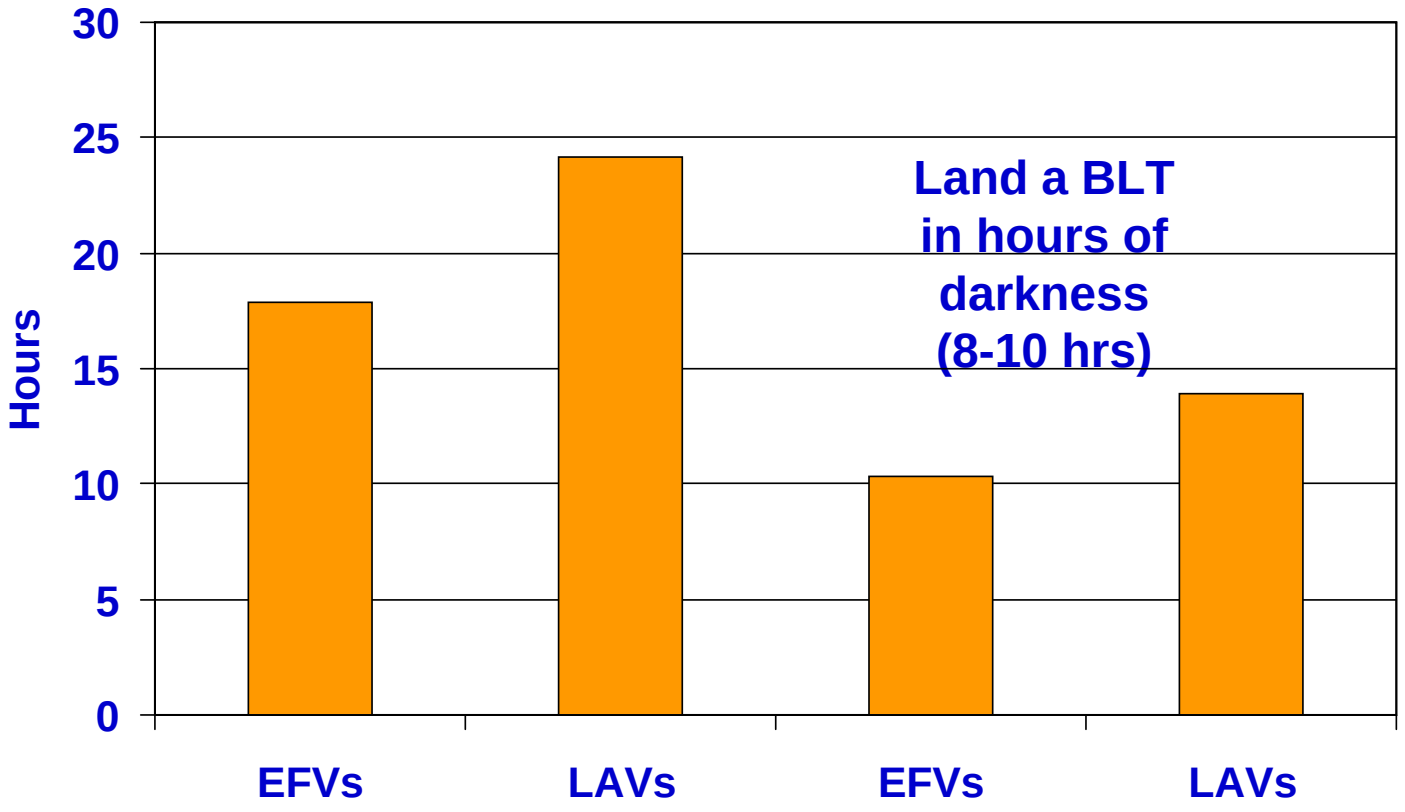
Forces Going Ashore

- **Two BLTs with:**
  - **2 – Infantry Battalions**
    - **Each with EFV or LAV Company**
  - **2 – Tank Companies**
  - **2 – LAR Companies**
  - **2 – Combat Engineer Spt Dets**
- **2 – DS CSS Companies**
  - **2 – LAAD Detachments**
  - **2 – LW155 Batteries**

Item	EFV-equipped	LAV-equipped
PAX	3,818	3,818
EFV	98	0
Tank	28	28
HMMWV wpn carrier	70	70
HMMWV cargo/comm	238	238
LW 155	12	12
LAV	56	290
MTVR	98	98
LVSR	38	38
LCAC Loads	143	193

Surface STOM Results

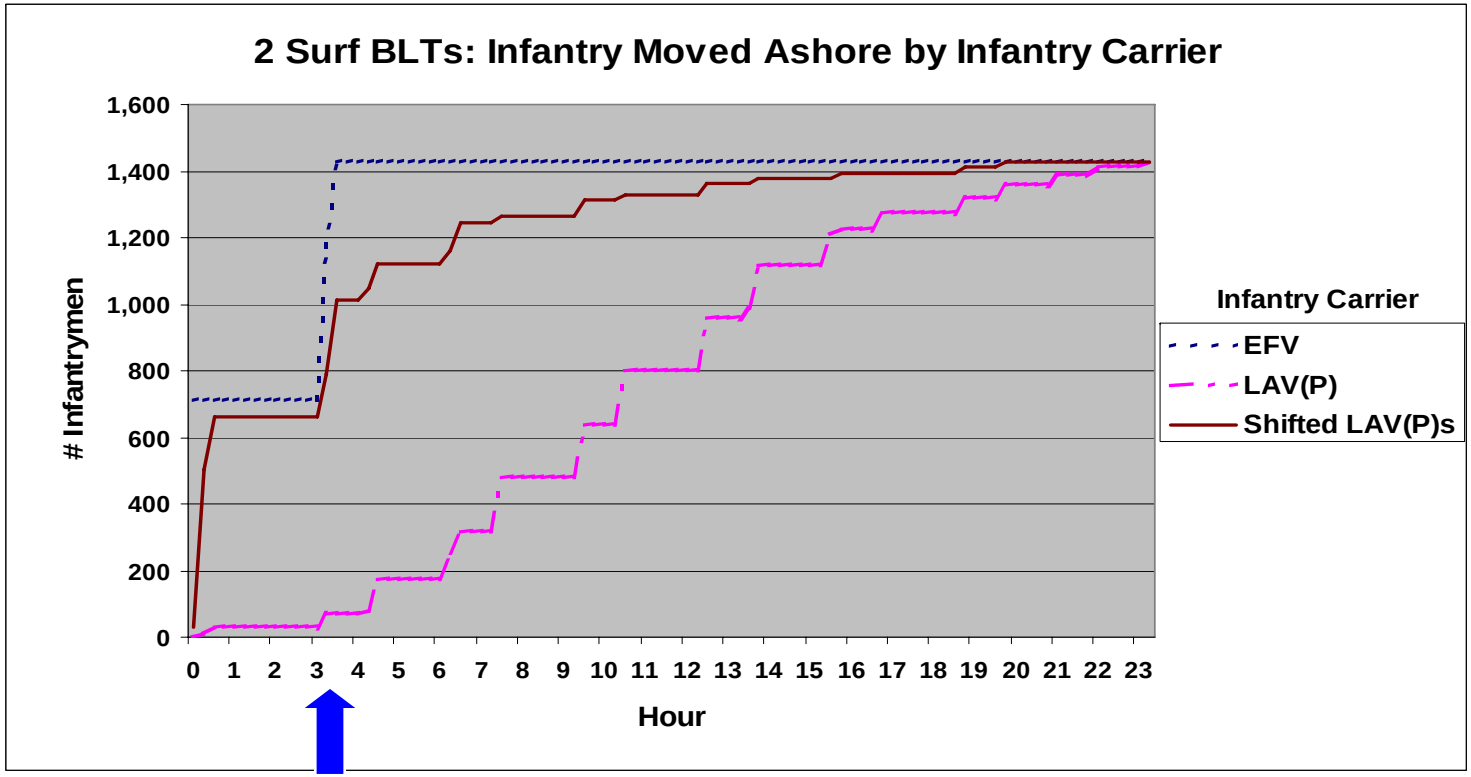
Time to Complete Landing



2 Surface BLTs

1 Surface BLT

Infantry Moved Ashore Over Time



 # Infantrymen landed in 3.5 hours with :

- **LAV(P)s: 71**
- **Shifted LAV(P)s: 1,014**
- **EFVs: 1,426**

Purpose

Analyze the impact of any changes to the reliability requirements of the EFV

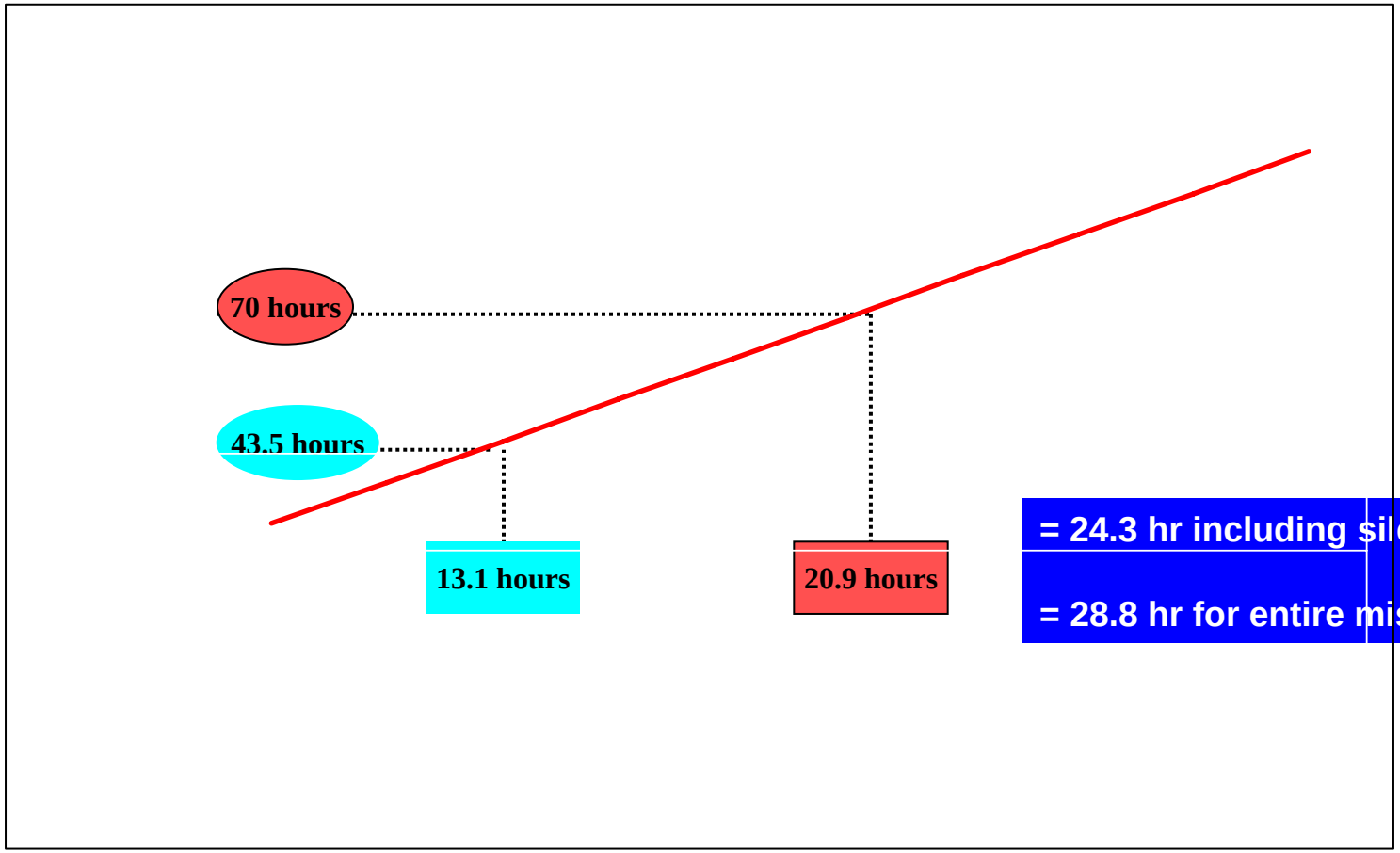
- **Original Threshold: 70 hrs Mean Time Between Operational Mission Failure (MTBOMF)**
- **Revised KPP: 43.5 hrs MTBOMF**
- **Rationale**
  - **Comparable systems significantly lower**
  - **Mission profiles used in derivation unrealistic**

Reliability Comparisons

Program	ORD Req't	Normalized Req't MTBOMF	Demonstrated at MS III
AAAV	70 Hrs MTBOMF	70 Hrs	N/A
AAV RAM/RS	43.5 Hrs MTBOMF	43.5 Hrs	58 Hrs
ABRAMS	320 MMBOMF[1]	32 Hrs	42 Hrs
BRADLEY	280 MMBOMF[1]	28 Hrs	36 Hrs
CRUSADER	62 Hrs MTBSA (SPH) 104 Hrs MTBSA (RV)	62 Hrs (SPH) 104 Hrs (RV)	N/A
GRIZZLY	21 Hrs MTBOMF	21 Hrs	N/A

Relation between Mission Duration and MTBOMF (Objective)

Initial goal: 75%* probability of completing the mission



Initial KPP (70 hours MTBOMF) actually achieved 74% mission reliability